STRESS INTENSITY FACTORS FOR WELD TOE CRACKS IN WELDED "T" PLATE JOINTS

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SUMMARY

This report presents the results of finite element investigations of the stress intensity factors at weld toe cracks of welded "T" plate joints.

This report is a condensed version of D.S.S. Contract Reports OSU82-00233 and OST84-00125:

"Determination of Stress Intensity Factors For Weld Toe Defects" [7] and [8].

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1. INTRODUCTION

During the past number of years there has been an increasing and justified interest in the use of fracture mechanics procedures for estimating the fatigue life and the development and propagation of fatigue cracks in large offshore structures. Current design practice utilizes the S-N design curve approach and this will remain to be the primary method for some years to come. However, fracture mechanics procedures do present a method of dealing with a tubular structure which contains flaws and demonstrates the influence of a number of variables on the propagation of fatigue cracks. However the testing and analysis of full scale tubular joints is a costly and time consuming undertaking, therefore in many cases the crack propagation behaviour from the weld toe has been studied using welded "T" plate specimens loaded in 3-point and 4-point bending, Figure 1.

The Canadian Offshore Steels Research program has concentrated on experimental fatigue investigations of welded plate, (Figure 2) and tubular joints and on the application of fracture mechanics procedures to the understanding of the fatigue crack propagation behaviour at the weld toe. The experimental results of this program are reported in references [1]-[5].

To supplement this experimental program a linear elastic fracture mechanics (LEFM) fatigue life prediction model has been developed under CANMET contract at Carleton University. This work has been reported in [6].

This report describes the development of the stress intensity factor (SIF) relationships which were incorporated in the above life prediction model. These SIF calculations were described in detail in [7] and [8].

From the Canadian experimental program results which are summarized in Figure 3 it can be seen that the life of welded "T" plate joints is dominated by fatigue crack propagation and this accounts for about 70% of the life. This crack growth starts at small initial flaws at the weld toe which grow under the influence of cyclic loading into small cracks, which are initially close to semi-circular shape. These cracks grow deeper and coalesce and finally grow as a single crack until failure of the specimen. Therefore, after making various assumptions on initial crack size and shape it is possible to describe the growth rate of a crack at the weld toe using a linear elastic fracture mechanics (LEFM) approach, in which the growth rate of the crack can be described by a single parameter, the stress intensity factor K. In this approach the crack growth rate da/dN is related to the stress intensity range ΔK by a law such as the Paris Law [9]

$$da/dN = C\,\Delta K^{m} \qquad (1)$$

where C and m are material constants, and ΔK is given by

$$\Delta K = Y \Delta\sigma\sqrt{\pi a} \qquad (2)$$

and Y is a factor describing the geometry. The stress intensity factor, K describes the stress environment at the crack tip and for two different geometries of the same material the stress distribution will be identical if the stress intensities are equal. It follows that the fatigue crack propagation rate in two bodies will be the identical if the cyclic variation in ΔK is the same. The value of K for complex geometries is best obtained using the finite element method and this procedure will be described in the following sections.

2. S.I.F. DETERMINATION BY FEM.

The numerical calculations of SIF were performed using the general purpose finite element program ASAS [10]. Both 2-D and 3-D analyses of the welded joints were carried out. The joints were modelled using quadratic isoparametric elements and the crack tip region by collapsed isoparametric elements which prescribe the $1/\sqrt{r}$ singularity at the crack tip, [11]. The stress intensity factors were evaluated using the classical Westergaard equations for displacements in the vicinity of the crack tip. In order to carry out the analyses at a reasonable cost the multi-level substructuring capabilities of the program was used extensively to perform the analysis for different loadcases and crack geometries.

3. 2-D SOLUTIONS FOR K

A series of 2-D analyses were carried out for crack depth ratios, a/t, varying from 0.005 - 0.7, where a is the crack depth and t is the plate thickness. This procedure models the crack as a straight fronted crack (SFC). Three weld shapes were chosen arbitrarily for investigation of the effect of weld shape on the SIF at the weld toe. A 70° weld was chosen to be representative of a severe weld shape, a 45° shape as typical of an actual weld profile and a 30° weld shape as representative of a weld after profiling, as shown in Figure 4 The finite element models were loaded in tension, 3-point bending, (load-carrying weld), and also in 4-point bending, (non-load-carrying weld). A typical 2-D finite element mesh is shown in Figure 5.

The results obtained from this series of analyses were normalized with respect to K for a plate without a weld and presented in terms of a SIF magnification factor Mk [12].

Hence: $$K = M_K K' \quad (3)$$

where K' is the K_I value of the edge cracked plate and M_k is the correction factor to account for the presence of the weld. The value of K' was calculated using the formulae presented by Rooke and Cartwright [13].

The SIF results for a/t ratios ranging from 0.005 - 0.7 for the above weld shapes and loading cases are given in Tables 1 and 2 and are presented graphically in Figures 6 and 7.

It is evident from Tables 1 and 2 that the weld angle has a significant effect on the stress intensity factor for small crack sizes. The effect of weld profiling can be demonstrated by considering the results shown in Table 3; for example for a crack depth ratio of a/t = 0.005 there is a 30% reduction in M_K between a simulated weld of 70° and a profiled weld of 30°. This effect disappears rapidly with increasing crack depth.

Using the finite element results of Tables 1 and 2 for the 3-point bending loadcase empirical expressions were obtained for M_K as a function of a/t. A log-log plot of M_K vs a/t confirmed that there were two regions which were governed by different power relationships between M_k and a/t. These regions are a/t < 0.1 and 0.1 < a/t < 0.7. Empirical relationships are fitted to the finite element results in these two regions.

In the region a/t < 0.1 the effect of the weld is significant and a power relationship of the following form was obtained.

$$M_K = C\ (a/t)^m \quad (4)$$

where C and m are functions of the weld angle θ. The following values of C and m were obtained for the values of weld angle considered:

θ	C	m
30°	0.758	-0.218
45°	0.668	-0.278
70°	0.594	-0.329

It is of interest to note that Gurney and Johnston [14] obtained the same value of m for a 45° weld angle on a cruciform joint loaded in tension.

C and m can be obtained by the following approximate expressions for the weld angles considered (30° ≤ θ ≤ 70°).

$$C = 0.582 \sin \theta^{-0.136} \quad (5)$$

$$m = -0.3447 \sin \theta^{0.652} \quad (6)$$

All results obtained using equations 5 and 6 for a/t < 0.1 are in agreement

with the finite element results to within ± 3% .

In the region a/t > 0.1 the effect of the weld geometry on the values of M_K is less significant and the following expression is found to fit the results quite well.

$$M_K = 1.031\ (a/t)^{-0.111} \tag{7}$$

All the results obtained using this expression for a/t > 0.1 agree with the finite element results to within ± 2% .

Using this procedure for the 4-point bending loadcase the values for C and m in equation (4) for a/t < 0.1 are given by

$$C = 0.563 \sin \theta^{-0.391} \tag{8}$$

$$m = -0.3358 \sin \theta^{0.644} \tag{9}$$

and for a/t > 0.1 M_K can be calculated from

$$M_K = 1.029\ (a/t)^{-0.056} \tag{10}$$

4. 3-D SOLUTION FOR K

Modelling semi-elliptical weld toe cracks in "T" plate joints is both time consuming and the data production is both tedious and error prone. Therefore a mesh generator was developed to produce the required 3-D finite element meshes. This mesh generator is described in detail in [7]. Also the substructure analysis capability of the finite element program was used to make the series of analyses more cost effective. Again this analysis procedure is described in [7].

The calculations were performed for crack shapes in the range

$$1.0 > a/c > 0.25$$

and for crack depths

$$0.005 > a/t > 0.4$$

The nomenclature for the elliptical crack shape is shown in Figure 8. The loading conditions and the weld shapes considered were those described in the previous section. A typical 3-D mesh for the crack tip region and a diagram of the substructure analysis are shown in Figures 9 and 10.

In order that the stress intensity factor data could be utilized in a fatigue life prediction program it was necessary to fit curves to the data. However, it was not possible to fit simple expressions to the SIF results because they vary with both crack shape, c/a and crack depth, a/t.

Therefore a method utilizing bi-cubic spline functions was chosen to fit a surface to the variation of SIF with a/t and c/a. The advantage of this method is that the entire domain of the surface can be represented by coefficients. In order to evaluate a SIF one simply has to produce a fundamental B-spline for the particular coordinates of the independent variables which when multiplied by the appropriate coefficients produce the curve fitted value.

Using this procedure it is possible to reproduce the original finite element SIF results to within several percentage points.

Tables 4 to 21 present the variation of SIF with crack shape, c/a and crack depth ratio, a/t for a weld toe crack in a "T" plate joint with weld angles of 30°, 45° and 70° loaded in tension, 4-point bending and 3-point bending. The results are presented for the deepest point and surface points of the crack.

The stress intensity results were normalized in two ways:

1. The SIF results obtained are presented in terms of a SIF magnification factor, M_K, which when multiplied by the SIF for a surface crack in a plate subjected to pure bending, gives the SIF for a weld toe crack as shown in equation (11).

$$K_{I,\ weld} = M_K \times K_{I,\ (pure\ bending)} \tag{11}$$

The solution for $K_{I\ (pure\ bending)}$ was obtained from the empirical relationship of Newman and Raju [15] for a surface crack.

2. The SIF results are also presented as a non-dimensional parameter Y. In this case the stress intensity factor for a weld toe crack can be obtained by multiplying Y by the stress intensity for an embedded circular crack loaded in simple tension as shown in equation (12).

$$K_{I,\ weld} = Y \times K_{I,\ circular\ crack} \tag{12}$$

The solution for an embedded circular crack is obtained from:

$$K_{I,\ circular\ crack} = \sigma\sqrt{\pi a/Q} \tag{13}$$

where $Q = \pi^2/4$.

In order to compare the 2-D and 3-D SIF's for the "T" plate and to demonstrate the variation of SIF with crack shape and weld angle the results were normalized with respect to an embedded circular crack and presented in Figure 11 for the 3-point bending loadcase. In can be seen from this figure the weld angle only effects the SIF results over the first 10% of the thickness of the plate.

5. CONCLUSIONS

1. Stress intensity factor results obtained using 2-dimensional finite elements have been presented for a range of weld toe cracks with crack depths between a/t = 0.005 and 0.7 for weld profiles of 30°, 45° and 70°.

2. Empirical relationships were fitted to the 2-dimensional results. These equations agree with the finite element results to within 2 - 3% depending on the crack depth.

3. Stress intensity factor results are reported for a series of semi-elliptical crack shapes for cracks at the weld toe of "T" plate joints. Bi-cubic expressions were fitted to the finite element results and the agreement with the original finite element results is very good.

4. The above stress intensity expressions for welded "T" plate joints have been incorporated in a fatigue life prediction program for welded "T" plate joints. This work is reported in [6].

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TABLE 1

Variation of M_k with a/t for 3-Point Bending

	M_k		
a/t	30° weld	45° weld	70° weld
0.005	2.443	2.978	3.514
0.01	2.064	2.390	2.680
0.015	1.882	2.121	2.390
0.02	1.754	1.938	2.090
0.03	1.630	1.765	1.854
0.04	1.489	1.604	1.676
0.05	1.454	1.522	1.570
0.07	1.367	1.416	1.449
0.08	1.336	1.378	1.404
0.1	1.331	1.332	1.353
0.3	1.160	1.161	1.60
0.5	1.122	1.122	1.122
0.7	1.074	1.074	1.074

TABLE 2

Variation of M_K with a/t for 4-Point Bending

	M_K		
a/t	30° weld	45° weld	70° weld
0.005	2.331	2.791	3.271
0.01	1.945	2.247	2.471
0.015	1.800	2.002	2.175
0.02	1.692	1.852	1.967
0.03	1.563	1.674	1.745
0.04	1.447	1.526	1.586
0.05	1.387	1.447	1.483
0.07	1.308	1.353	1.370
0.08	1.282	1.314	1.333
0.1	1.256	1.270	1.284
0.3	1.115	1.112	1.115
0.5	1.085	1.093	1.093
0.7	1.074	1.080	1.080

TABLE 3

% Difference in M_x Between 3-Point and 4-Point Bending Cases

	% Difference Between 3 and 4 Point Bending		
a/t	30° weld	45° weld	70° weld
0.005	4.8	6.3	7.4
0.01	6.1	6.3	8.4
0.015	4.5	5.9	6.2
0.02	3.6	4.6	6.3
0.03	4.3	5.1	5.4
0.04	2.9	5.1	5.7
0.05	4.8	5.1	5.9
0.07	4.5	4.6	5.8
0.08	4.2	4.9	5.3
0.1	5.9	4.9	5.3
0.3	4.0	4.3	4.0
0.5	3.4	1.7	1.7
0.7	-	-	-

TABLE 4

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN
LOADED IN TENSION, WITH A
70 DEGREE WELD PROFILE
AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.32650	1.22341	1.33359	1.34690	1.35420
.030	1.27804	1.16165	1.26120	1.26950	1.27828
.035	1.23875	1.11419	1.20733	1.21471	1.22370
.040	1.20670	1.07791	1.16780	1.17716	1.18545
.045	1.17994	1.04967	1.13838	1.15148	1.15851
.050	1.15653	1.02634	1.11490	1.13230	1.13787
.075	1.06124	.93760	1.02554	1.05716	1.05722
.100	.99551	.88481	.97110	1.00560	1.00309
.150	.93051	.85257	.93385	.95367	.95173
.200	.91710	.86064	.93681	.93741	.93840
.250	.91637	.85491	.92801	.92503	.92652
.300	.91140	.84084	.91301	.91391	.91460
.350	.90140	.83437	.90642	.90721	.90780
.400	.92800	.83375	.90142	.90211	.90260

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.380	1.554	1.876	2.091	2.199
.030	1.330	1.476	1.775	1.972	2.077
.035	1.290	1.416	1.700	1.888	1.990
.040	1.257	1.370	1.645	1.830	1.929
.045	1.229	1.335	1.604	1.792	1.886
.050	1.205	1.306	1.572	1.763	1.854
.075	1.108	1.196	1.450	1.653	1.732
.100	1.041	1.132	1.379	1.581	1.654
.150	.977	1.099	1.339	1.521	1.597
.200	.968	1.120	1.361	1.523	1.612
.250	.973	1.125	1.370	1.538	1.637
.300	.974	1.121	1.373	1.560	1.669
.350	.971	1.129	1.391	1.595	1.717
.400	1.008	1.146	1.414	1.636	1.775

TABLE 5

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN TENSION, WITH A 45 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	1.70870	1.53199	1.69381	1.77473	1.76980
.015	1.56168	1.41731	1.55793	1.60794	1.60841
.020	1.44627	1.32379	1.44826	1.47684	1.48092
.025	1.35805	1.24869	1.36133	1.37650	1.38269
.030	1.29262	1.18922	1.29366	1.30200	1.30905
.050	1.17064	1.05258	1.14596	1.16380	1.16748
.075	1.09348	.95842	1.04820	1.08303	1.08188
.100	1.03326	.90139	.98820	1.02729	1.02409
.150	.95635	.86376	.94597	.97030	.96827
.200	.92543	.86977	.94824	.95159	.95270
.250	.92363	.86425	.93920	.93756	.93919
.300	.92446	.85095	.92384	.92519	.92600
.350	.91423	.84431	.91685	.91760	.91830
.400	.94001	.84283	.91096	.91179	.91240

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	1.777	1.944	2.381	2.752	2.871
.015	1.624	1.799	2.190	2.494	2.610
.020	1.505	1.681	2.037	2.292	2.404
.025	1.413	1.586	1.915	2.137	2.246
.030	1.345	1.511	1.821	2.022	2.127
.050	1.220	1.339	1.616	1.812	1.903
.075	1.141	1.222	1.482	1.693	1.772
.100	1.080	1.153	1.403	1.615	1.688
.150	1.004	1.113	1.357	1.547	1.625
.200	.977	1.132	1.378	1.546	1.636
.250	.981	1.137	1.387	1.559	1.659
.300	.988	1.135	1.389	1.579	1.690
.350	.985	1.142	1.407	1.613	1.737
.400	1.021	1.158	1.429	1.654	1.794

TABLE 6

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN TENSION, WITH A 30 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.35020	1.24644	1.35691	1.36591	1.37080
.030	1.31108	1.18577	1.28859	1.30107	1.30515
.035	1.27771	1.14008	1.23797	1.25358	1.25703
.040	1.24898	1.10597	1.20100	1.21939	1.22236
.045	1.22377	1.08005	1.17360	1.19445	1.19705
.050	1.20098	1.05894	1.15172	1.17472	1.17702
.075	1.10669	.97654	1.06630	1.09602	1.09724
.100	1.03999	.92339	1.01059	1.04140	1.04211
.150	.96919	.87938	.96242	.98472	.98547
.200	.94820	.87596	.95549	.96530	.96650
.250	.94182	.87171	.94796	.95099	.95212
.300	.93570	.86332	.93749	.93860	.93940
.350	.92830	.85641	.92990	.93080	.93150
.400	.94860	.85432	.92409	.92499	.92560

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.405	1.583	1.909	2.121	2.226
.030	1.365	1.506	1.814	2.021	2.121
.035	1.330	1.449	1.743	1.948	2.044
.040	1.301	1.406	1.692	1.896	1.989
.045	1.275	1.374	1.654	1.859	1.949
.050	1.251	1.347	1.624	1.829	1.918
.075	1.155	1.245	1.508	1.714	1.797
.100	1.087	1.181	1.435	1.637	1.718
.150	1.018	1.133	1.380	1.570	1.654
.200	1.001	1.140	1.389	1.569	1.660
.250	1.000	1.147	1.400	1.581	1.682
.300	1.000	1.151	1.410	1.602	1.714
.350	1.000	1.159	1.427	1.636	1.762
.400	1.030	1.174	1.449	1.678	1.820

TABLE 7

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 4-POINT BENDING, WITH A 70 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.58940	1.46710	1.59790	1.61079	1.62080
.030	1.51727	1.36886	1.49039	1.51071	1.50595
.035	1.45586	1.29406	1.40903	1.43457	1.42301
.040	1.40309	1.23748	1.34796	1.37691	1.36441
.045	1.35688	1.19393	1.30130	1.33230	1.32259
.050	1.31516	1.15819	1.26320	1.29529	1.29000
.075	1.14291	1.02088	1.11571	1.14568	1.15722
.100	1.02149	.93581	1.02220	1.04100	1.05960
.150	.89323	.86982	.94422	.93006	.94409
.200	.85460	.85514	.92341	.88970	.89200
.250	.84064	.81261	.87936	.86043	.85999
.300	.82980	.76687	.83350	.83570	.83730
.350	.81480	.75276	.81800	.81990	.82130
.400	.80220	.74193	.80630	.80800	.80920

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.599	1.803	2.177	2.423	2.551
.030	1.516	1.672	2.018	2.259	2.357
.035	1.445	1.570	1.896	2.133	2.214
.040	1.383	1.492	1.803	2.035	2.111
.045	1.328	1.431	1.730	1.958	2.035
.050	1.279	1.379	1.669	1.892	1.974
.075	1.073	1.178	1.430	1.627	1.723
.100	.925	1.046	1.272	1.439	1.538
.150	.751	.911	1.108	1.220	1.306
.200	.662	.839	1.022	1.111	1.181
.250	.597	.745	.919	1.025	1.095
.300	.535	.656	.822	.953	1.028
.350	.472	.599	.761	.895	.974
.400	.412	.547	.707	.846	.930

TABLE 8

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN
LOADED IN 4-POINT BENDING, WITH A
45 DEGREE WELD PROFILE
AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	1.94840	1.97941	1.98280	1.98693	2.12120
.015	1.78009	1.80571	1.81330	1.82150	1.89892
.020	1.64563	1.66547	1.67547	1.68724	1.72366
.025	1.54037	1.55423	1.56513	1.57999	1.58889
.030	1.45965	1.46749	1.47809	1.49557	1.48813
.050	1.28907	1.27591	1.27927	1.30299	1.29499
.075	1.16574	1.14160	1.13819	1.16172	1.17258
.100	1.07016	1.05014	1.04546	1.06240	1.08150
.150	.94656	.95851	.96084	.95604	.97102
.200	.88699	.92650	.93691	.91670	.91890
.250	.86272	.89411	.90330	.88895	.88736
.300	.85528	.85934	.86191	.86430	.86590
.350	.84876	.83474	.83275	.84603	.85087
.400	.82725	.83284	.83584	.83740	.83860

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	1.999	2.479	2.751	3.043	3.398
.015	1.814	2.247	2.501	2.773	3.024
.020	1.666	2.060	2.296	2.553	2.729
.025	1.549	1.910	2.132	2.377	2.501
.030	1.458	1.792	2.001	2.236	2.329
.050	1.253	1.519	1.690	1.904	1.981
.075	1.095	1.317	1.459	1.650	1.746
.100	.970	1.173	1.301	1.468	1.570
.150	.795	1.004	1.127	1.254	1.343
.200	.687	.909	1.037	1.145	1.217
.250	.612	.820	.944	1.059	1.129
.300	.551	.735	.850	.985	1.063
.350	.492	.664	.775	.924	1.009
.400	.425	.614	.733	.877	.964

TABLE 9

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 4-POINT BENDING, WITH A 30 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.47360	1.36926	1.48581	1.48119	1.47850
.030	1.43205	1.28787	1.40394	1.42667	1.41109
.035	1.39389	1.22907	1.34343	1.38094	1.36025
.040	1.35866	1.18753	1.29933	1.34225	1.32212
.045	1.32594	1.15794	1.26667	1.30882	1.29283
.050	1.29529	1.13498	1.24050	1.27889	1.26852
.075	1.16596	1.04329	1.13551	1.15543	1.16633
.100	1.07140	.97853	1.06190	1.06800	1.08819
.150	.96186	.90665	.98184	.97250	.98823
.200	.91730	.87289	.94640	.93500	.93709
.250	.89530	.84085	.91304	.90841	.90734
.300	.88140	.81418	.88471	.88671	.88810
.350	.86790	.80140	.87070	.87250	.87370
.400	.84620	.79043	.86021	.86171	.86280

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.482	1.683	2.024	2.228	2.327
.030	1.431	1.573	1.901	2.133	2.208
.035	1.383	1.491	1.808	2.053	2.117
.040	1.339	1.432	1.738	1.984	2.046
.045	1.298	1.387	1.684	1.923	1.989
.050	1.259	1.351	1.639	1.868	1.941
.075	1.095	1.203	1.456	1.641	1.737
.100	.971	1.093	1.321	1.476	1.579
.150	.808	.950	1.152	1.275	1.367
.200	.711	.856	1.048	1.167	1.241
.250	.636	.771	.954	1.083	1.155
.300	.568	.697	.873	1.011	1.090
.350	.503	.638	.811	.953	1.037
.400	.435	.582	.755	.902	.992

TABLE 10

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 3-POINT BENDING, WITH A 70 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_K

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.62240	1.49498	1.62917	1.64551	1.65810
.030	1.54026	1.39512	1.51921	1.53870	1.53596
.035	1.47236	1.31844	1.43542	1.45771	1.44783
.040	1.41573	1.25985	1.37195	1.39666	1.38566
.045	1.36743	1.21422	1.32299	1.34965	1.34138
.050	1.32450	1.17648	1.28272	1.31080	1.30694
.075	1.14704	1.03130	1.12673	1.15391	1.16677
.100	1.02080	.94150	1.02810	1.04420	1.06391
.150	.88504	.87210	.94638	.92808	.94268
.200	.84340	.85642	.92450	.88600	.88840
.250	.83159	.81038	.87683	.85545	.85495
.300	.82340	.76110	.82730	.82960	.83120
.350	.80780	.74635	.81110	.81310	.81460
.400	.79650	.73529	.79890	.80070	.80190

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.632	1.837	2.219	2.475	2.610
.030	1.539	1.704	2.057	2.301	2.404
.035	1.461	1.600	1.932	2.167	2.253
.040	1.395	1.519	1.835	2.064	2.144
.045	1.339	1.455	1.759	1.983	2.064
.050	1.288	1.401	1.695	1.915	2.000
.075	1.077	1.190	1.445	1.639	1.738
.100	.925	1.052	1.279	1.443	1.544
.150	.744	.914	1.110	1.217	1.304
.200	.654	.840	1.024	1.106	1.177
.250	.590	.743	.916	1.020	1.088
.300	.531	.651	.816	.946	1.020
.350	.468	.594	.755	.888	.966
.400	.409	.542	.701	.839	.922

TABLE 11

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 3-POINT BENDING, WITH A 45 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.005	2.49710	2.64744	2.54816	2.20444	2.67330
.010	2.16175	2.25394	2.19907	2.00820	2.30921
.015	1.89672	1.94399	1.92201	1.84580	2.01918
.020	1.69321	1.70717	1.70807	1.71329	1.79410
.025	1.54246	1.53306	1.54836	1.60669	1.62483
.050	1.27243	1.23852	1.25171	1.32359	1.29652
.075	1.18694	1.16615	1.16078	1.17455	1.18476
.100	1.10528	1.09965	1.08795	1.06959	1.09669
.150	.96452	.98792	.98597	.95671	.97809
.200	.87221	.91067	.92456	.91450	.91372
.250	.84091	.87104	.88512	.88479	.87927
.300	.84506	.85539	.85951	.85860	.86122
.350	.84961	.84590	.84224	.83920	.84876
.400	.81948	.82475	.82780	.82990	.83108

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.005	2.579	3.337	3.558	3.396	4.308
.010	2.218	2.823	3.051	3.075	3.699
.015	1.933	2.419	2.651	2.810	3.215
.020	1.714	2.111	2.341	2.592	2.840
.025	1.551	1.884	2.109	2.417	2.557
.050	1.237	1.475	1.654	1.934	1.984
.075	1.115	1.345	1.488	1.668	1.764
.100	1.001	1.229	1.354	1.478	1.592
.150	.810	1.035	1.157	1.255	1.353
.200	.676	.893	1.024	1.142	1.210
.250	.597	.799	.925	1.054	1.119
.300	.545	.732	.848	.979	1.057
.350	.492	.673	.784	.916	1.007
.400	.421	.608	.726	.869	.955

TABLE 12

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 3-POINT BENDING, WITH A 30 DEGREE WELD PROFILE AT THE DEEPEST POINT OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.49700	1.38477	1.50388	1.50487	1.50790
.030	1.45346	1.30192	1.42039	1.44817	1.43567
.035	1.41359	1.24205	1.35863	1.40053	1.38132
.040	1.37690	1.19976	1.31354	1.36015	1.34068
.045	1.34288	1.16962	1.28008	1.32522	1.30957
.050	1.31104	1.14621	1.25320	1.29390	1.28384
.075	1.17637	1.05224	1.14502	1.16474	1.17593
.100	1.07743	.98516	1.06860	1.07330	1.09372
.150	.96181	.90890	.98408	.97348	.98932
.200	.91431	.87195	.94569	.93429	.93640
.250	.89181	.83847	.91073	.90638	.90536
.300	.87810	.81129	.88159	.88360	.88510
.350	.86400	.79796	.86699	.86879	.87010
.400	.84160	.78640	.85591	.85751	.85870

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.506	1.702	2.049	2.264	2.373
.030	1.452	1.590	1.923	2.165	2.247
.035	1.403	1.507	1.828	2.082	2.149
.040	1.357	1.447	1.757	2.010	2.074
.045	1.315	1.401	1.702	1.947	2.015
.050	1.275	1.365	1.656	1.890	1.964
.075	1.105	1.214	1.468	1.654	1.751
.100	.976	1.101	1.330	1.483	1.587
.150	.808	.952	1.155	1.277	1.368
.200	.709	.855	1.047	1.167	1.240
.250	.633	.769	.952	1.080	1.152
.300	.566	.694	.870	1.007	1.086
.350	.501	.635	.807	.949	1.032
.400	.432	.580	.751	.898	.987

TABLE 13

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN TENSION, WITH A 70 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_K

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.22840	1.99173	2.17217	2.22210	2.25600
.030	2.10432	1.83499	1.99875	2.05325	2.06153
.035	1.99914	1.72340	1.87475	1.92752	1.92985
.040	1.90934	1.64616	1.78838	1.83490	1.84543
.045	1.83140	1.59246	1.72782	1.76539	1.79269
.050	1.76181	1.55149	1.68130	1.70899	1.75609
.075	1.48547	1.38310	1.49053	1.47988	1.59500
.100	1.30749	1.25509	1.34680	1.31571	1.44983
.150	1.15748	1.09024	1.16523	1.13065	1.21291
.200	1.13339	.99703	1.06621	1.05081	1.05663
.250	1.09357	.92668	.99222	.99166	.98177
.300	1.04322	.87518	.93731	.94271	.94711
.350	1.01201	.84506	.90410	.90880	.91271
.400	.98070	.82053	.87798	.88220	.88588

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.551	2.272	2.377	2.191	2.016
.030	2.410	2.094	2.189	2.026	1.843
.035	2.290	1.968	2.054	1.903	1.727
.040	2.188	1.880	1.960	1.813	1.652
.045	2.100	1.820	1.895	1.746	1.607
.050	2.021	1.774	1.845	1.691	1.575
.075	1.708	1.587	1.643	1.472	1.439
.100	1.508	1.446	1.492	1.318	1.319
.150	1.346	1.271	1.309	1.153	1.127
.200	1.333	1.180	1.221	1.098	1.011
.250	1.303	1.117	1.162	1.068	.973
.300	1.262	1.078	1.128	1.051	.978
.350	1.246	1.067	1.121	1.054	.987
.400	1.231	1.064	1.126	1.068	1.007

TABLE 14

**S.I.F. FOR A WELDED 'T' PLATE SPECIMEN
LOADED IN TENSION, WITH A
45 DEGREE WELD PROFILE
AT THE SURFACE INTERSECTION OF THE CRACK.**

M_K

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	2.61420	2.74658	2.97314	2.86864	3.09800
.015	2.43294	2.42169	2.63090	2.59090	2.72085
.020	2.28016	2.16796	2.36213	2.36698	2.42846
.025	2.15230	1.97542	2.15663	2.18963	2.20882
.030	2.04581	1.83412	2.00415	2.05155	2.04991
.050	1.76244	1.58202	1.71988	1.74661	1.78152
.075	1.53379	1.43099	1.54189	1.52603	1.62199
.100	1.37906	1.31070	1.40377	1.36640	1.48051
.150	1.22806	1.14283	1.21962	1.18231	1.25365
.200	1.18275	1.03924	1.11237	1.09892	1.10493
.250	1.14049	.96691	1.03619	1.03772	1.03017
.300	1.09471	.91727	.98221	.98791	.99251
.350	1.05779	.88580	.94811	.95291	.95700
.400	1.02170	.85988	.92101	.92531	.92910

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	2.990	3.130	3.251	2.852	2.764
.015	2.784	2.761	2.877	2.553	2.429
.020	2.610	2.472	2.584	2.333	2.169
.025	2.464	2.254	2.360	2.159	1.974
.030	2.343	2.093	2.195	2.024	1.833
.050	2.022	1.809	1.888	1.729	1.598
.075	1.764	1.642	1.699	1.518	1.464
.100	1.591	1.510	1.555	1.368	1.347
.150	1.429	1.332	1.370	1.206	1.165
.200	1.391	1.230	1.273	1.149	1.057
.250	1.359	1.166	1.214	1.118	1.021
.300	1.324	1.130	1.182	1.102	1.025
.350	1.302	1.118	1.176	1.105	1.034
.400	1.282	1.115	1.181	1.120	1.056

TABLE 15

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN TENSION, WITH A 30 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	1.98350	1.80135	1.95913	1.98022	1.99660
.030	1.90585	1.69297	1.84352	1.87989	1.88062
.035	1.83701	1.61625	1.76026	1.80105	1.79958
.040	1.77563	1.56354	1.70158	1.73892	1.74484
.045	1.72038	1.52718	1.65974	1.68870	1.70777
.050	1.66991	1.49949	1.62699	1.64559	1.67974
.075	1.46765	1.38209	1.48886	1.46729	1.55319
.100	1.33552	1.28668	1.37929	1.33758	1.43823
.150	1.21809	1.14842	1.22711	1.18618	1.24843
.200	1.19044	1.05784	1.13289	1.11588	1.12090
.250	1.15212	.99258	1.06539	1.06448	1.05771
.300	1.10952	.94834	1.01840	1.02300	1.02688
.350	1.08281	.92222	.98960	.99370	.99709
.400	1.04040	.89902	.96692	.97051	.97370

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.271	2.055	2.144	1.953	1.784
.030	2.183	1.932	2.019	1.855	1.681
.035	2.105	1.845	1.928	1.778	1.610
.040	2.035	1.786	1.865	1.718	1.562
.045	1.973	1.745	1.821	1.670	1.530
.050	1.916	1.715	1.786	1.629	1.507
.075	1.688	1.586	1.641	1.460	1.402
.100	1.541	1.483	1.528	1.340	1.308
.150	1.417	1.339	1.379	1.210	1.160
.200	1.400	1.252	1.297	1.166	1.072
.250	1.373	1.196	1.248	1.146	1.048
.300	1.342	1.168	1.225	1.141	1.060
.350	1.333	1.164	1.227	1.153	1.078
.400	1.306	1.166	1.240	1.175	1.107

TABLE 16

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 4-POINT BENDING, WITH A 70 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_K

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.88970	2.60379	2.83521	2.88243	2.92120
.030	2.74139	2.36288	2.57975	2.67000	2.65869
.035	2.60714	2.19874	2.40239	2.50643	2.47839
.040	2.48534	2.09233	2.28393	2.38062	2.36003
.045	2.37438	2.02463	2.20520	2.28150	2.28333
.050	2.27262	1.97659	2.14699	2.19800	2.22800
.075	1.87293	1.76233	1.89212	1.85461	1.98475
.100	1.62552	1.56732	1.67092	1.60601	1.76940
.150	1.43669	1.24875	1.32999	1.31902	1.42458
.200	1.40440	1.04827	1.12512	1.18870	1.19798
.250	1.29868	.97265	1.04213	1.09303	1.08215
.300	1.17660	.94600	1.00661	1.01520	1.02237
.350	1.12669	.89732	.95291	.96051	.96689
.400	1.07610	.85753	.91060	.91750	.92330

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	3.271	2.940	3.072	2.816	2.586
.030	3.097	2.663	2.791	2.605	2.351
.035	2.940	2.474	2.596	2.442	2.189
.040	2.797	2.351	2.464	2.317	2.082
.045	2.667	2.271	2.376	2.218	2.012
.050	2.548	2.214	2.310	2.134	1.962
.075	2.081	1.959	2.023	1.793	1.742
.100	1.791	1.732	1.778	1.548	1.550
.150	1.558	1.365	1.406	1.269	1.251
.200	1.503	1.138	1.186	1.149	1.062
.250	1.373	1.051	1.100	1.066	.974
.300	1.231	1.021	1.068	1.004	.939
.350	1.169	.969	1.018	.967	.911
.400	1.108	.928	.983	.943	.895

TABLE 17

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 4-POINT BENDING, WITH A 45 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	3.06830	3.46302	3.51271	3.26595	3.70590
.015	2.85366	3.06320	3.09588	2.98636	3.23648
.020	2.67263	2.75109	2.77100	2.75668	2.87285
.025	2.52104	2.51433	2.52503	2.57030	2.60002
.030	2.39472	2.34052	2.34498	2.42061	2.40296
.050	2.05883	2.02719	2.02350	2.05679	2.07231
.075	1.79080	1.82413	1.81390	1.77041	1.87571
.100	1.61280	1.64712	1.62650	1.56120	1.69850
.150	1.44397	1.37076	1.32534	1.31497	1.40705
.200	1.38644	1.19716	1.13413	1.19941	1.20751
.250	1.30779	1.11737	1.05454	1.11598	1.10077
.300	1.20961	1.09023	1.03844	1.04682	1.05313
.350	1.12699	1.06659	1.02528	.99419	1.02219
.400	1.09500	.99726	.95450	.96041	.96560

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.010	3.494	3.930	3.825	3.205	3.294
.015	3.243	3.470	3.366	2.926	2.873
.020	3.031	3.111	3.008	2.697	2.547
.025	2.854	2.839	2.736	2.511	2.302
.030	2.706	2.638	2.537	2.362	2.125
.050	2.308	2.270	2.177	1.997	1.825
.075	1.990	2.028	1.940	1.711	1.646
.100	1.777	1.820	1.731	1.505	1.488
.150	1.566	1.499	1.401	1.266	1.236
.200	1.483	1.300	1.196	1.159	1.070
.250	1.383	1.208	1.113	1.089	.991
.300	1.266	1.176	1.101	1.036	.967
.350	1.169	1.152	1.096	1.001	.963
.400	1.127	1.080	1.030	.988	.936

TABLE 18

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 4-POINT BENDING, WITH A 30 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.18520	1.98856	2.16191	2.18229	2.20280
.030	2.11509	1.84712	2.01838	2.08400	2.07971
.035	2.04671	1.75412	1.92084	2.00349	1.99265
.040	1.98074	1.69732	1.85780	1.93698	1.93272
.045	1.91788	1.66447	1.81776	1.88068	1.89103
.050	1.85880	1.64333	1.78922	1.83081	1.85871
.075	1.62631	1.54091	1.65705	1.62261	1.71192
.100	1.48318	1.43213	1.52970	1.47001	1.57851
.150	1.37433	1.22403	1.30756	1.28884	1.35770
.200	1.35088	1.07619	1.15900	1.20191	1.20803
.250	1.27638	1.02323	1.10209	1.13866	1.13169
.300	1.19403	1.00963	1.08252	1.08811	1.09281
.350	1.16143	.97747	1.04701	1.05201	1.05620
.400	1.11400	.94940	1.01898	1.02349	1.02740

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.474	2.245	2.343	2.132	1.950
.030	2.390	2.082	2.184	2.033	1.839
.035	2.308	1.974	2.075	1.952	1.760
.040	2.229	1.907	2.004	1.885	1.705
.045	2.154	1.867	1.958	1.828	1.667
.050	2.084	1.840	1.925	1.778	1.637
.075	1.807	1.713	1.772	1.568	1.502
.100	1.634	1.582	1.628	1.417	1.383
.150	1.491	1.338	1.382	1.240	1.192
.200	1.445	1.168	1.222	1.162	1.071
.250	1.349	1.106	1.163	1.111	1.018
.300	1.249	1.089	1.148	1.076	1.004
.350	1.205	1.055	1.119	1.059	.995
.400	1.147	1.028	1.100	1.052	.996

TABLE 19

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 3-POINT BENDING, WITH A 70 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.98250	2.67310	2.91352	2.97499	3.02680
.030	2.82338	2.43227	2.65731	2.75494	2.74611
.035	2.68112	2.26725	2.47824	2.58502	2.55451
.040	2.55345	2.15923	2.35736	2.45388	2.42996
.045	2.43814	2.08943	2.27576	2.35019	2.35044
.050	2.33292	2.03907	2.21450	2.26259	2.29390
.075	1.91981	1.81312	1.94510	1.90204	2.04416
.100	1.66373	1.60697	1.71110	1.64079	1.81991
.150	1.46678	1.26928	1.35012	1.33861	1.45447
.200	1.43034	1.05645	1.13320	1.20089	1.21081
.250	1.31719	.97664	1.04583	1.09993	1.08759
.300	1.18822	.94902	1.00879	1.01789	1.02542
.350	1.13558	.89766	.95210	.96010	.96691
.400	1.07850	.85531	.90752	.91461	.92080

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	3.376	3.018	3.157	2.906	2.680
.030	3.190	2.741	2.875	2.688	2.428
.035	3.023	2.551	2.678	2.519	2.256
.040	2.874	2.426	2.543	2.388	2.144
.045	2.739	2.344	2.452	2.285	2.072
.050	2.616	2.284	2.383	2.197	2.020
.075	2.133	2.016	2.080	1.839	1.794
.100	1.833	1.775	1.821	1.581	1.595
.150	1.591	1.388	1.427	1.288	1.277
.200	1.530	1.147	1.195	1.161	1.073
.250	1.393	1.056	1.104	1.073	.979
.300	1.243	1.024	1.070	1.007	.942
.350	1.178	.969	1.017	.967	.911
.400	1.110	.926	.980	.940	.893

TABLE 20

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN LOADED IN 3-POINT BENDING, WITH A 45 DEGREE WELD PROFILE AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.005	3.70806	3.58886	3.54611	3.65769	3.97560
.010	3.32590	3.28630	3.27032	3.32437	3.51837
.015	3.01271	3.03248	3.03581	3.04622	3.15006
.020	2.76075	2.82174	2.83790	2.81680	2.85972
.025	2.56177	2.64846	2.67190	2.62971	2.63644
.050	2.07227	2.14600	2.15694	2.10450	2.14310
.075	1.83725	1.84794	1.83314	1.80593	1.91332
.100	1.67186	1.62544	1.59119	1.58749	1.71729
.150	1.48898	1.35356	1.29621	1.32954	1.41667
.200	1.40163	1.22316	1.15861	1.20769	1.22167
.250	1.31167	1.14301	1.08123	1.11981	1.11047
.300	1.21628	1.08576	1.03164	1.04719	1.05220
.350	1.13651	1.04002	.99358	.99194	1.01372
.400	1.09340	.99440	.95083	.95619	.96190

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.005	4.232	4.081	3.868	3.595	3.593
.010	3.787	3.730	3.561	3.262	3.128
.015	3.424	3.436	3.300	2.984	2.796
.020	3.131	3.191	3.080	2.756	2.535
.025	2.900	2.990	2.895	2.569	2.334
.050	2.324	2.403	2.321	2.043	1.887
.075	2.042	2.055	1.960	1.746	1.679
.100	1.842	1.796	1.693	1.530	1.505
.150	1.615	1.480	1.370	1.280	1.244
.200	1.500	1.328	1.222	1.167	1.083
.250	1.387	1.235	1.141	1.092	.999
.300	1.273	1.172	1.094	1.036	.967
.350	1.179	1.123	1.062	.999	.955
.400	1.125	1.076	1.026	.983	.932

TABLE 21

S.I.F. FOR A WELDED 'T' PLATE SPECIMEN
LOADED IN 3-POINT BENDING, WITH A
30 DEGREE WELD PROFILE
AT THE SURFACE INTERSECTION OF THE CRACK.

M_x

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.22240	2.02359	2.19990	2.21969	2.23840
.030	2.15699	1.88224	2.05650	2.12248	2.11173
.035	2.08940	1.78877	1.95850	2.04183	2.02285
.040	2.02139	1.73106	1.89455	1.97429	1.96237
.045	1.95475	1.69702	1.85330	1.91640	1.92093
.050	1.89125	1.67456	1.82341	1.86470	1.88916
.075	1.64194	1.56562	1.68444	1.64834	1.74305
.100	1.49062	1.45079	1.55062	1.48941	1.60699
.150	1.38179	1.23270	1.31740	1.29990	1.37529
.200	1.36437	1.07881	1.16179	1.20819	1.21460
.250	1.28767	1.02421	1.10270	1.14158	1.13360
.300	1.19990	1.01034	1.08260	1.08849	1.09348
.350	1.16562	.97646	1.04519	1.05049	1.05500
.400	1.11600	.94693	1.01570	1.02050	1.02460

Y

a/t	c/a				
	1.0	1.5	2.0	3.0	4.0
.025	2.516	2.285	2.384	2.168	1.982
.030	2.437	2.122	2.225	2.071	1.867
.035	2.356	2.013	2.116	1.989	1.787
.040	2.275	1.945	2.044	1.921	1.731
.045	2.196	1.904	1.997	1.863	1.693
.050	2.121	1.875	1.962	1.811	1.664
.075	1.825	1.741	1.801	1.593	1.530
.100	1.642	1.603	1.650	1.435	1.408
.150	1.499	1.348	1.393	1.251	1.208
.200	1.460	1.171	1.225	1.168	1.076
.250	1.361	1.107	1.164	1.114	1.020
.300	1.256	1.090	1.148	1.077	1.004
.350	1.209	1.054	1.117	1.058	.994
.400	1.149	1.025	1.096	1.049	.993

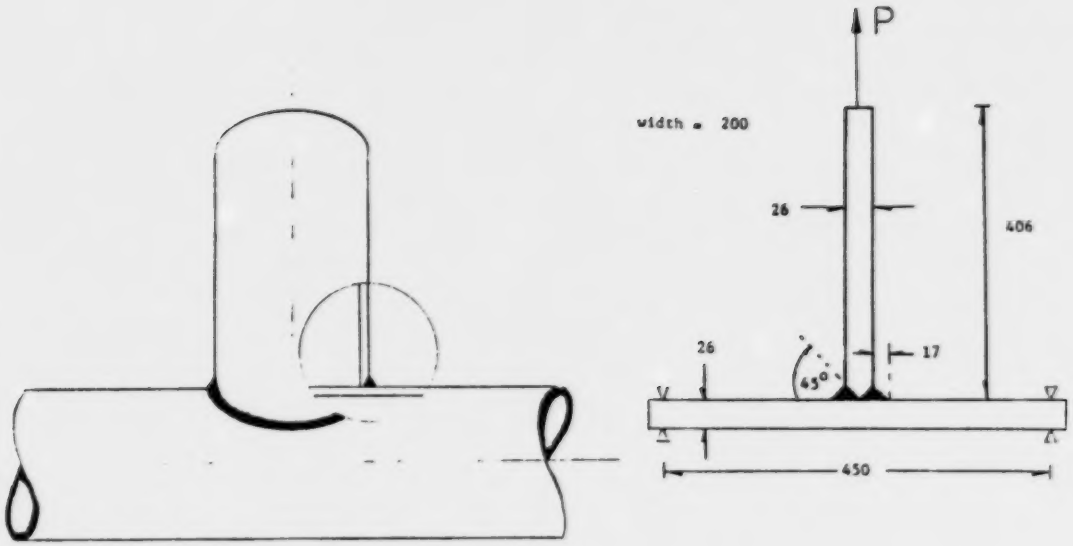
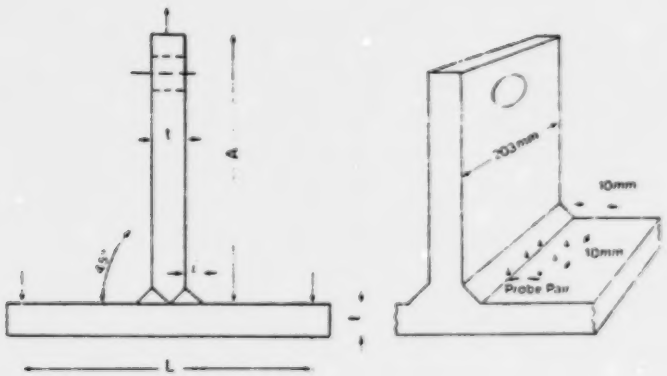


Figure 1



JOINT	t (mm)	i (mm)	L (mm)	A (mm)
A	16	8-12	300	406
B	26	14-18	442	406
C	52	26 30	442	406
D	78	38-42	584	457
E	103	52 56	726	457

Figure 2

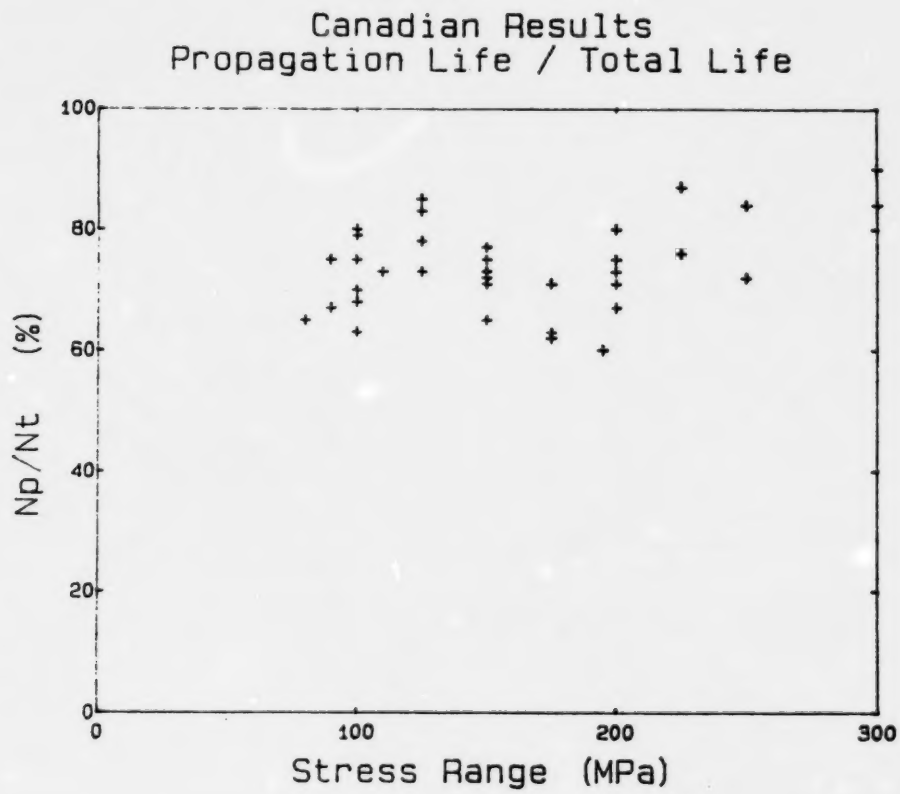


Figure 3

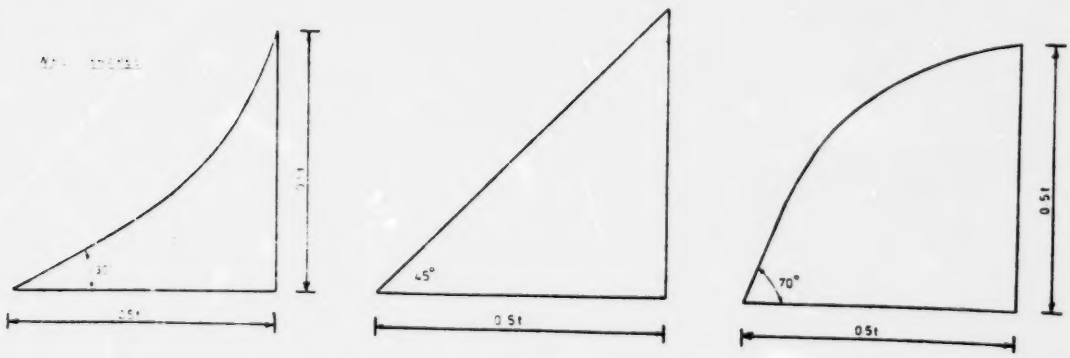
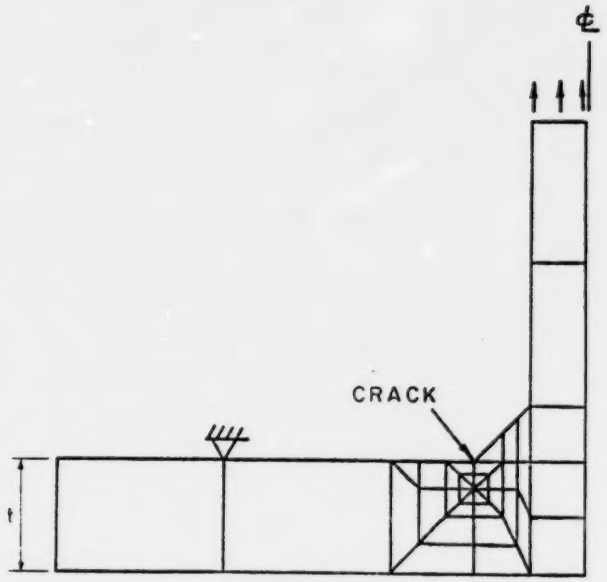
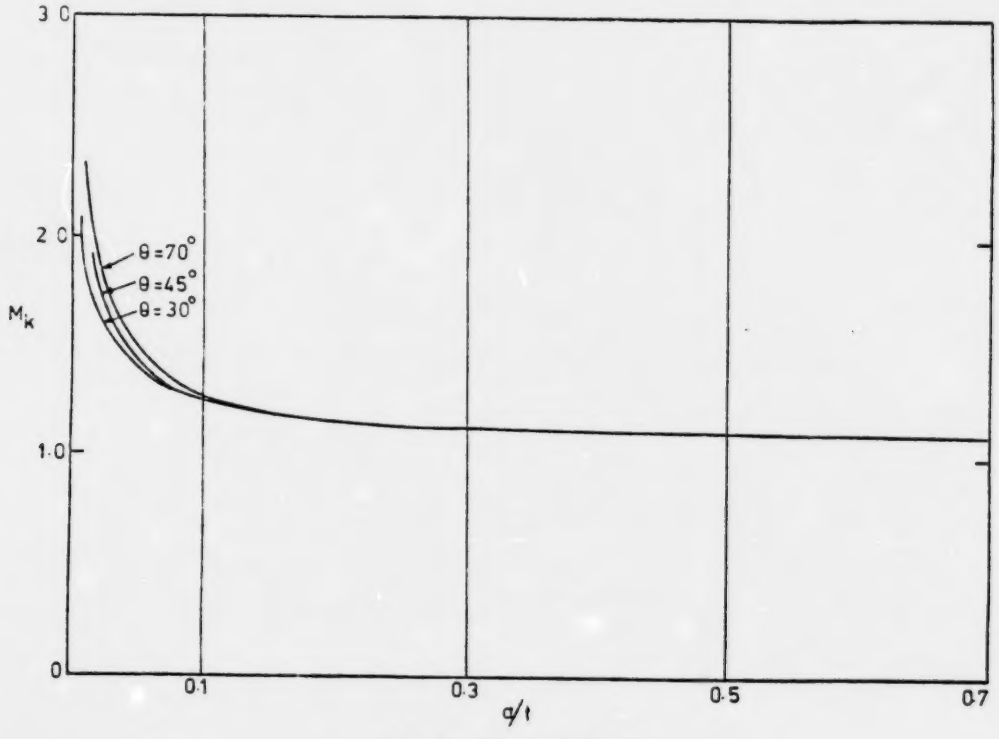


Figure 4



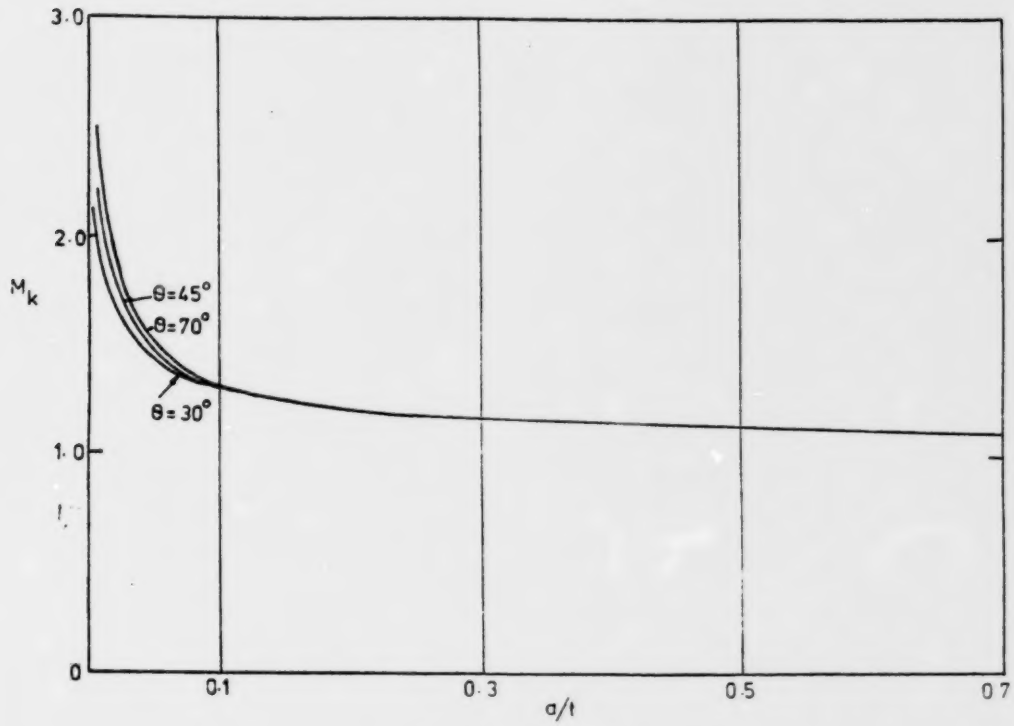
FE MODEL FOR "T" SPECIMEN

Figure 5



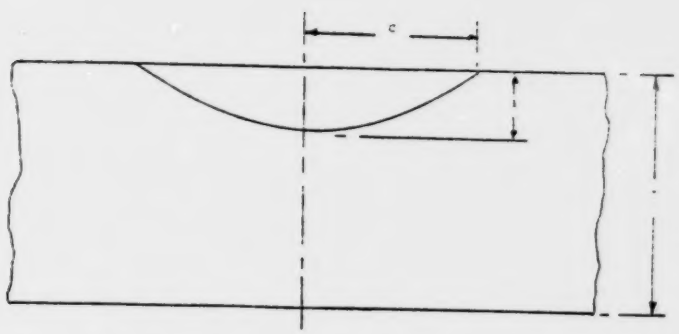
M_k vs a/t FOR PURE BENDING

Figure 6



M_k vs a/t FOR 3 POINT BENDING

Figure 7



CRACK NOMENCLATURE

Figure 8

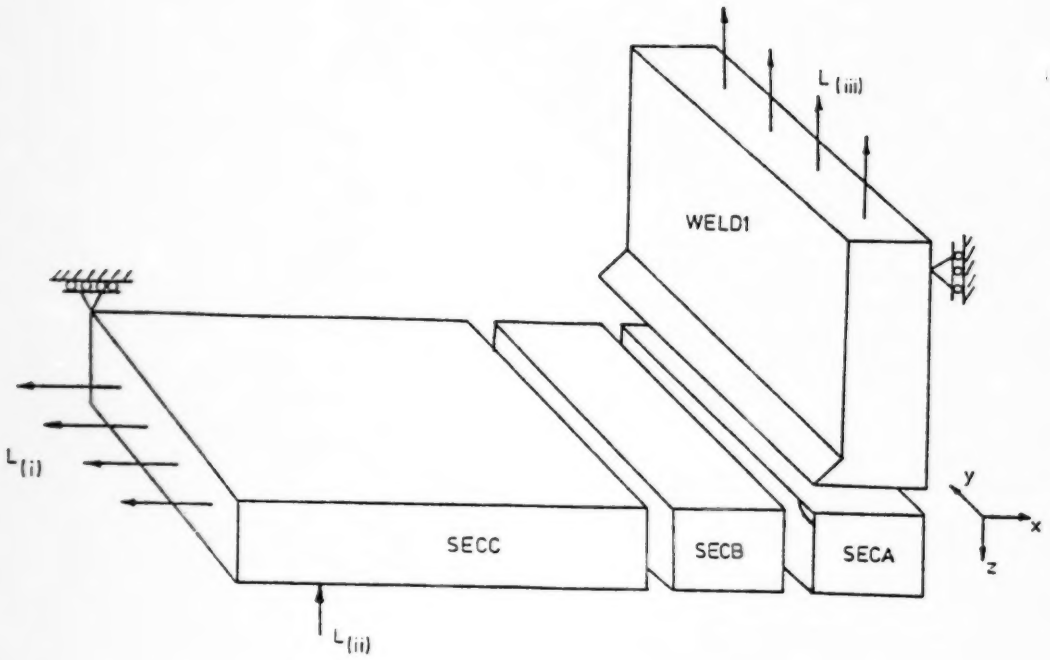
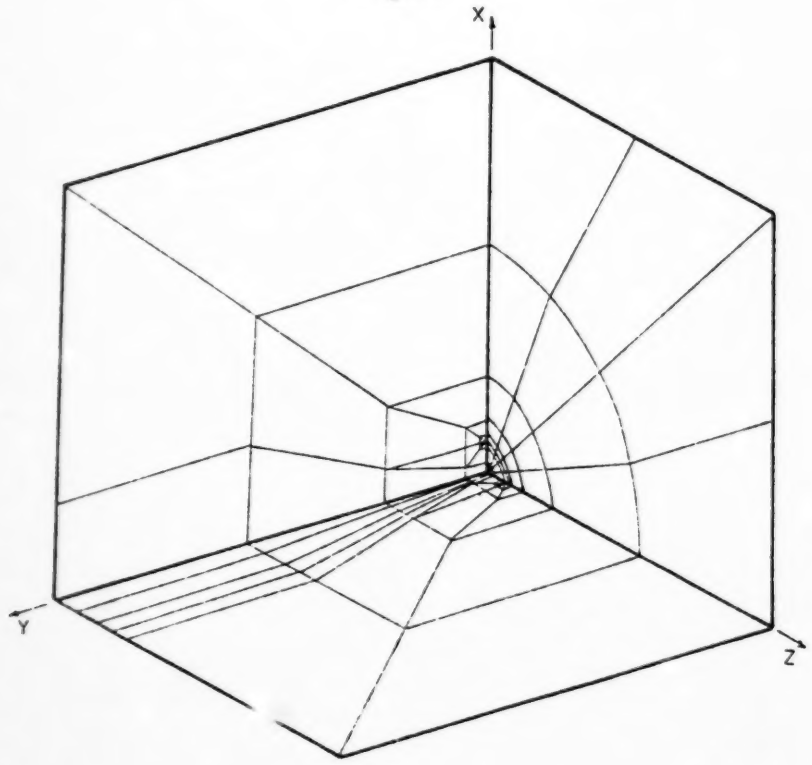


Figure 9



3 D MESH FOR TENSION BLOCK
PRODUCED BY MESH GENERATOR

Figure 10

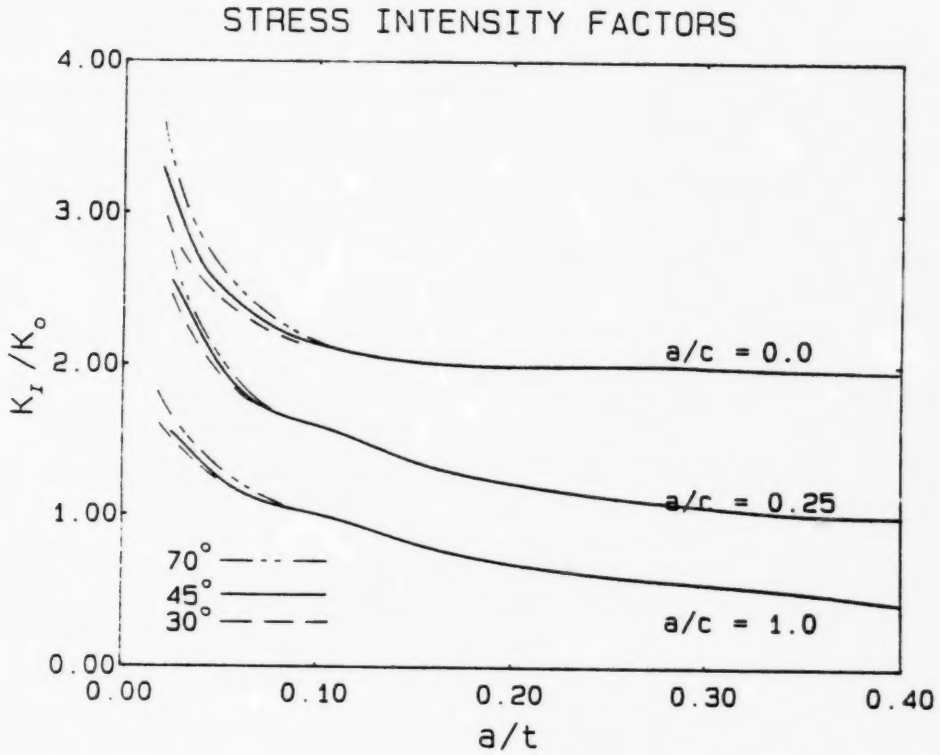

STRESS INTENSITY FACTORS
4.00
3.00
2.00
1.00
0.00
K_I / K_o
a/c = 0.0
a/c = 0.25
a/c = 1.0
70°
45°
30°
0.00
0.10
0.20
0.30
0.40
a/t

Figure 11